WASTEWATER AND WASTE REDUCTION

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Charles L. McEntyre
Tennessee Valley Authority
Chattanooga, TN

BACKGROUND

When Congress created the Tennessee Valley Authority (TVA) they mandated that the agency promote economic development and protect the natural resources within the Tennessee Valley. TVA's Industrial Waste Reduction (IWR) program helps meet two of TVA's goals; economic development and protecting the environment. IWR coordinates with EPA's pollution prevention (P2) programs in Region IV and the nation and with state P2 programs. TVA developed and pioneered with Tennessee the concept of using retired engineers and scientists to provide P2 assistance to industries in a very cost-effective program. A study done by the Tennessee program with many of the industries they had assisted showed $36 dollars in annual savings by the industries for each $1 used to provide the assistance. IWR also occasionally provides direct assistance at the request of our distributors or with one of our partners in P2.

For many industries an increasing problem is managing their wastewater in a cost-effective manner. Water is used for many purposes: heat transfer, reaction media, cleaning, transport media, and others. One reason that water is so useful is that many things are soluble in water. Water is often called the universal solvent.

More stringent regulations governing wastewater discharges both directly to streams and indirectly to city sewers will continue this trend. If your plant discharges directly to waters of the US, you must have a National Pollutant Discharge Elimination System Permit or NPDES. Fines for NPDES violations can now be $25,000 per day per violation. If your industrial facility discharges to a Publicly Owned Treatment Works (POTW) you must normally have an indirect discharge permit. These have steadily become more stringent. The Clean Water Act's Section 503 sludge disposal regulations will continue this trend.

Many industries generate significant amounts of wastewater. Examples include: food processing, organic chemicals, pulp & paper, textiles, etc. Other industries which do not use water in their primary process may generate wastewater's from cooling towers, steam condensate, etc.

For example, the metal finishing industry can generate significant amounts of wastewater. Also much of this industry's hazardous waste is generated from on-site wastewater treatment systems. Our experience with this industry has shown that pollution prevention/waste reduction is the most cost-effective method for ensuring environmental protection. Small, concentrated streams of wastewater can be treated more efficiently than large, dilute streams and normally for less money. The fabricated metals business (SIC 34) is a significant portion of the Valley's industrial base. The operations which normally occur in this industry include: machining, treating, cleaning, coating, and/or plating metal parts. Individual facilities may use one or all of these operations

Not only does pollution prevention (P2) protect the environment, it often results in cost savings and increased worker safety. A study presented by Dr. Charles Rooney at the recent Southern States Environmental Conference in Biloxi, MS, stated that for many industrial facilities the true, total costs of waste equaled or exceeded the cost of labor for the entire facility. P2 includes product and process changes to reduce the toxicity and/or quantity of wastes generated. P2 does NOT include waste treatment and disposal. The most effective P2 technique is to make it everyone's job just as safety should be part of everyone's job. Your people know your plant and your operation better than any outsider. Get each person from purchasing, maintenance, production, and waste management to see that wastes represent inefficiency and lost profits. Effective P2 always requires top management commitment. EPA's Facility Pollution Prevention Guide (EPA/600/R-92/088) is an excellent guide to setting up an in-house pollution prevention program.

Every facility can achieve some P2 through better standard procedures, good operating practices, improved materials handling and storage, inventory control, cost allocation, and wastes segregation.

Also each of the fabricated metals operations mentioned above has P2 techniques which have proven effective. For example, in machining the primary wastes of concern are metalworking fluids. P2 techniques include: standardizing fluids, sump and machine cleaning, gasket and seal maintenance, and recycling fluids. In this paper I will concentrate on the operations most common to electroplaters, cleaning and plating.

ELECTROPLATING

Cleaning Operations

Cleaning operations are common to many industries. EPA has published manuals devoted to waste reduction for metal parts cleaning and solvents. To get good quality plating the surfaces must be clean. Therefore, most plating operations are preceded by various cleaning operations. These may involve solvents (i.e. trichloroethylene, 1,1,1-trichloroethane), aqueous alkaline cleaners, acid pickler, abrasives, or just water. The primary wastes are spent cleaning solutions.

P2 Techniques

Common approaches to P2 include source control and substitution of cleaning agents. For source control, lids, sideboards, and chillers can be added to tanks to reduce loss and spillage. Improved handling practices can reduce cross-contamination, sludge buildup, and dragout. Working with suppliers may reduce contaminants on metal surfaces and thus increase cleaner life (peel coatings, just-in-time delivery).

Spent solvent waste coming from contaminated solvents from parts cleaning operations may be reduced by the following measures:

- Use water-soluble cutting fluids instead of oil-based fluids (this could eliminate the need for solvent cleaning);
- Use aqueous cleaners;
- Use multi-stage countercurrent cleaning;
- Prevent cross-contamination or drag-in from other processes;
- Prompt removal of sludge from tank; and
- Reduce the number of different solvents used (a single larger waste that is more amenable to recycling).

Solvent loss from air emissions may be reduced by proper operation of equipment as it is designed.

- Use roll-type covers, not hinged covers (up to 50% reduction in emissions);
- Increase freeboard height;
- Install freeboard chillers;
- Use silhouette entry covers;
- Proper equipment layout;
- Avoid rapid insertion and removal of items (less than 11 feet/min.);
- Avoid inserting oversized objects into the tank (cross-sectional area of the item should be less than 50% of tank area to reduce piston effect);
- Allow for proper drainage before removing item; and
- Avoid water contamination of solvent in degreasers.

Techniques to reduce waste rinsewater will be discussed in the section on plating.

Plating Operations

Plating operations involve immersing the objects to be plated in various combinations of plating baths, rinses, and final coatings. The workpiece can be carried on racks or in barrels. Plating baths are either acid or alkaline. Acid baths may include the following: chrome plating, chromic acid plastic etch, chromic acid bright dip, nickel, copper sulfate, precious metals, and fluorborates. Alkaline baths may include cyanide formulations of zinc, copper, cadmium, brass, bronze, or silver. The primary wastes are: spent plating baths, rinse waters, filter sludges, spills and leaks, and waste treatment wastes. Some or all of the waste types may be combined into a single stream before treatment and disposal.

Most electroplating hazardous waste is generated from plating rinsewater, electroplating sludges, and sludges from the treatment of waste rinsewaters. Contaminated rinsewater accounts for a majority of waste produced. Rinsewater is used to remove the drag-out from a workpiece. Drag-out refers to the excess cleaning or plating solution that adheres to the workpiece surface, and gets carried out of the bath along with the workpiece.

Spent plating solutions contain high concentrations of metals. These solutions are not regularly discarded but may require purging if impurities build up.

The wastewater produced in the electroplating process may contain a variety of heavy metals and cyanide. The metals are removed by adding lime or other precipitation agents. The result is a dilute metal hydroxide sludge, which is thickened and then disposed of by landfilling. P2 measures which reduce wastes from plating baths and rinses will normally result in significant reductions in volumes of wastewater treatment system sludges.

P2 Techniques

Various techniques are effective in reducing wastewater, treatment sludges, and hazardous wastes for electroplaters. Reducing dragout reduces wastes throughout the plating line. This may be done with: rack & barrel design, workpiece positioning and design, increased drip times, reduced withdrawal speed, and use of surfactants.

Spent Plating Solutions and Sludges - Plating solutions are not discarded frequently, but do require periodic replacement. Many platers whose product specifications allow it have stopped using cyanide baths because of the costly, hazardous materials involved. Also, zinc has replaced the use of cadmium in many applications.

Reduction practices available for minimizing spent plating waste include: use deionized or distilled water for make-up, regenerate plating solution through impurity removal, return spent plating solution to manufacturer, and metal recovery.

Metal recovery techniques include: evaporation, reverse osmosis, ion exchange, electrolysis, and electrodialysis. Many companies have installed such systems to recover metals from waste rinsewater and have found that the investment has paid for itself in one to five years. Strategic, in-line placement of metal recovery units, such as ion-exchange columns, can serve to remove metals from spent plating baths and waste rinsewaters. When the ion-exchange resin is regenerated, the metals can be recovered and used to provide plating solutions which can be recycled to the plating baths.

Rinsewaters - Conserving water is an effective way to cut operating and capital costs. These methods can be grouped into two major techniques: drag-out reduction and rinsewater reduction.

Reducing the drag-out reduces the amount of rinsewater needed and the amount of metal in the wastewater. Also, less of the plating solution metals leave the process, which produces savings in raw materials, and treatment and disposal costs. The amount of drag-out depends on the following factors: surface tension and viscosity of the plating solution, shape and surface area of the workpiece and rack, speed of workpiece withdrawal, and drainage time.

Generally, drag-out reduction techniques include:

- Increase solution temperature;
- Use less concentrated plating solution;
- Withdraw workpieces slowly from solution;
- Add wetting agents to plating solution;
- Position workpieces properly on rack;
- Increase drip times (10-30 seconds);
- Use drip boards or pans (direct drips back to origin);
- Install fog nozzles and sprays;

Rinsewater reduction involves rinsing off the workpiece in the most efficient manner, using the smallest volume of rinsewater. Traditionally, a workpiece would be immersed into a single rinsing bath following a plating bath, and then moved on to the next step in the process. Decreasing water consumption without reducing drag-out will result in a smaller, but more concentrated wastewater.

Several methods exist which use less rinsewater than the traditional method, while still adequately rinsing the workpiece. These include:

- Counter-flow multiple tank rinsing
- Fog nozzles and sprays rinses on simple workpieces, such as sheets
- Still rinses
- Flow or conductivity controls
- Mechanical and air agitation of the rinses

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